OPERATIONAL FACTORS AND COSTS OF CARGO AIRSHIP OPERATIONS

Presentation to

"Cargo Airships for Northern Operations"

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AGENDA

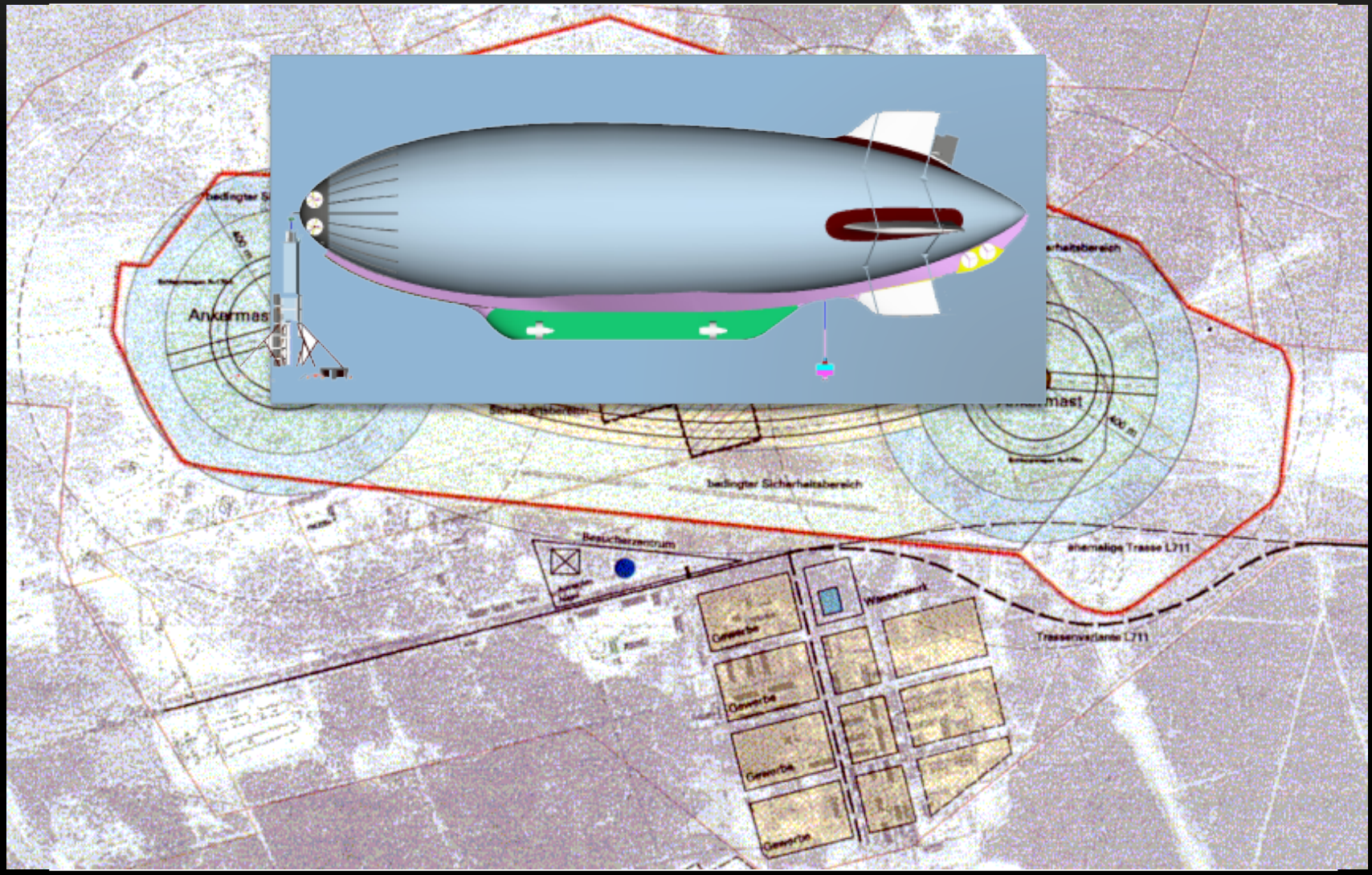
- Background and History
- Lessons Learned
- A Simple Example Problem
- A More Complex Example Problem
- A Possible Way Forward

BACKGROUND

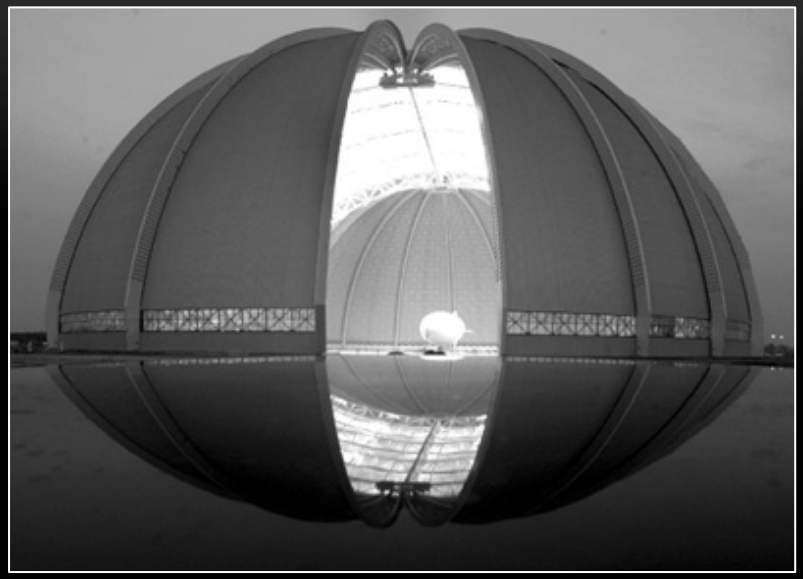
- Idea of Cargo Airship Operations, even in Northern Climes, is not new…
  - ITALIA Expedition
  - Other, more recent examples (e.g. CargoLifter, WALRUS, etc.)
- Modeling of Cost, Schedule, and Performance in ANY Business is not new…
  - We have come a long way from the “back of the envelope”
  - Successful businesses will tell you that they do this, and have for quite some time…
  - We are now even so bold as to treat these problems inclusive of uncertainty
- Strangely, putting these things together, in an open and transparent fashion, APPEARS to be a novel concept

TRIVIA QUESTION: WHERE IS THIS?

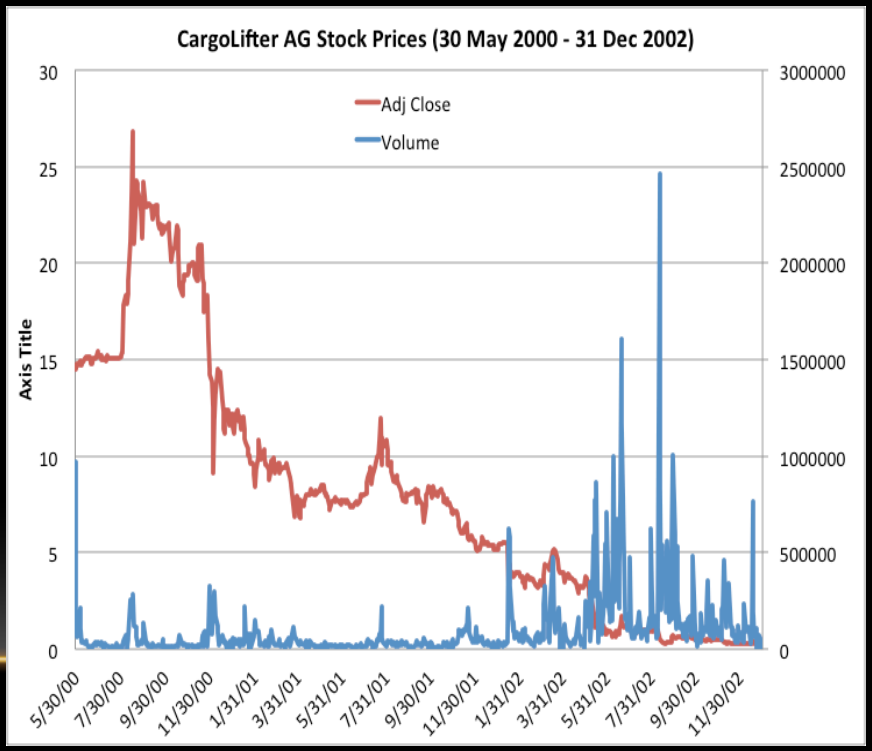
HOW DID IT GO FROM THIS…



TO THIS?




CargoLifter


CargoLifter AG Stock Prices (30 May 2000 - 31 Dec 2002)
Adj Close
Volume
Axis Title
30
25
20
15
10
5
0
3000000
2500000
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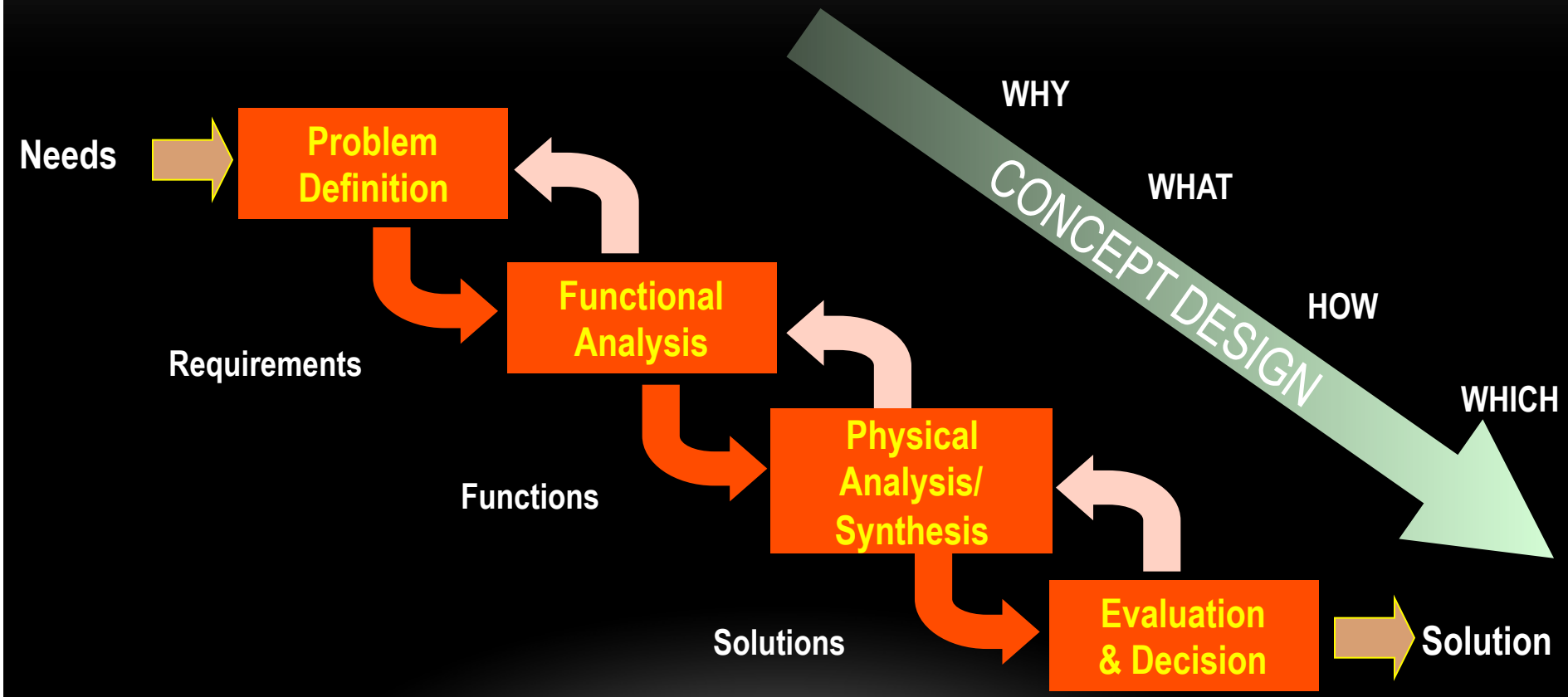
DISCLAIMER #1

… just in case the statute of limitations is not up …

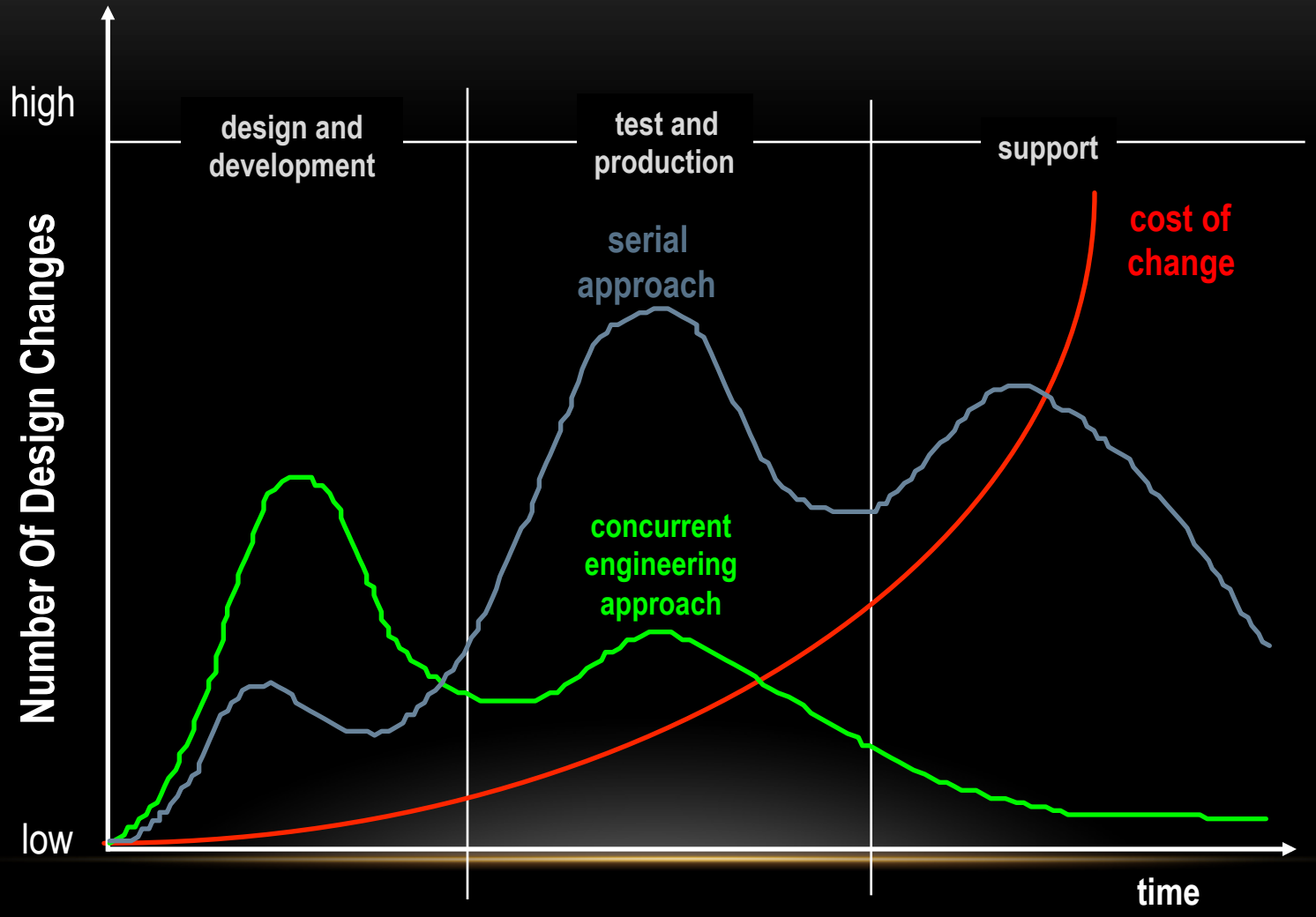
WHY DID CL FAIL?

- Three simple reasons:
  - Did NOT stick to a timeline
  - Did NOT make the tough design decisions
  - Did NOT properly estimate the real nature (key factors and costs) of their intended operations
- Combined, these reasons would have been enough to do in any company, let alone a very green startup…
  - But it gets worse.
- These reasons I cite did not happen in a parallel fashion…
  - They came, in actual fact, as a serial cascade of failures
  - Each individual failure was largely avoidable.

SYSTEM ENGINEERING PROCESS



TRADITIONAL SERIAL APPROACH VERSUS A CONCURRENT SYSTEMS ENGINEERING APPROACH



SO… HOW TO AVOID DOING IT AGAIN?

- Understand your Requirements
  - BEFORE you start procuring and fabricating
  - DURING the building and testing cycle
  - AFTER you have deployed and are operating
- Do rigorous but right-sized analysis at each step of the way
  - Consider ALL options for how you satisfy the requirements
  - Fairly trade options against one another on consistent basis
  - Don’t be paralyzed by the fact that the data is not complete
- When you find requirements that drive the entire enterprise to the edge of feasibility (or beyond…), deal with it immediately
  - call it out, understand it, and mercilessly work it… EARLY.

DEFINING REQUIREMENTS…

- Set up at least one (or better yet, a reasonable bounding set of) Design Reference Missions (DRMs)
  - Call out a variety of mission-focused operational profiles that the enterprise might need to address
  - Include the impact on non-airship system components in the DRM
- Question EVERYTHING implied by the DRM and operational profiles, constantly.
  - Revisit initial assumptions, and challenge their validity
  - Assess not just how well the design handles the DRM, but how well it deviates from it…
- The Ultimate Goal:
  - Enhance the Perception of declining risk and increasing rewards…

DISCLAIMER #2

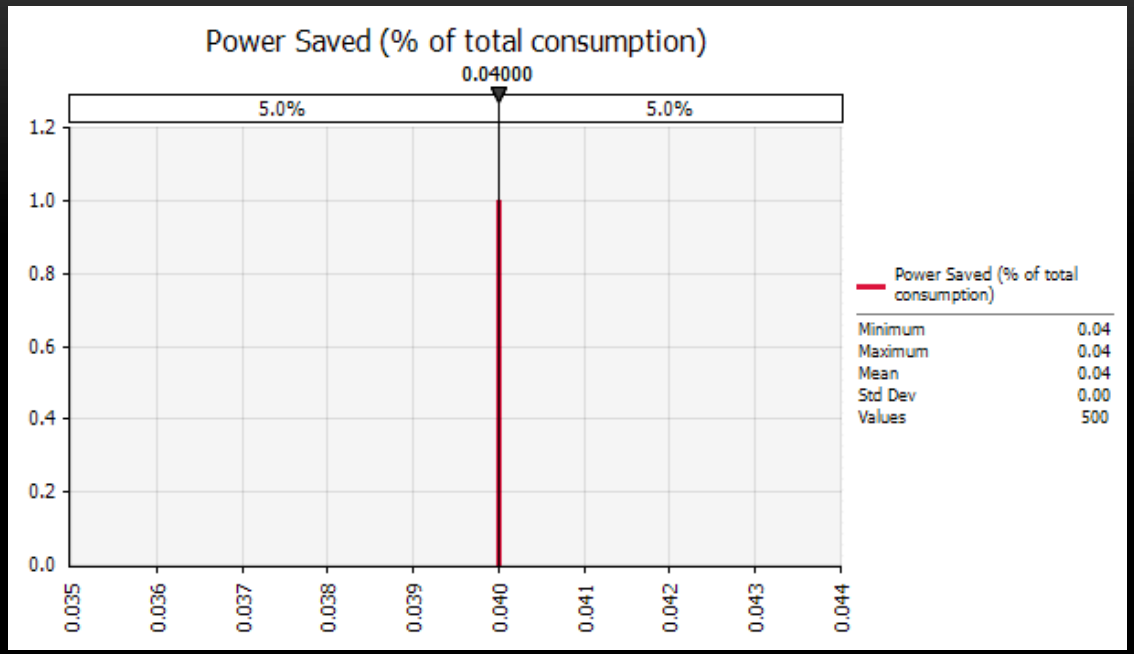
… Garbage in, Garbage out STILL applies, but maybe not *quite* as much as it used to…

A SIMPLE SAMPLE PROBLEM (TO GET YOU IN THE MOOD…)

- Say you have a modification to an existing platform, that has potential to save you a some amount of fuel consumption, as soon as you can get it installed.
- However, there are still a fair number of unknowns…
  - What is the actual % savings to be seen at each speed
  - What is the actual % of time to be spent operating at each speed
  - What is the actual base level of power consumed at each speed
- In spite of the uncertainties, The Deputy PM wants this done Very Badly
  - Accordingly, you have been asked to assess, with “realism included”
  - Bottom line is to report on whether this is a good idea, or not…
- How are you going to go about it?

THE DEPUTY PM'S VIEW…

			Savings			Operatons
Speed (kts)	Power (MW)		Low%	High%		%Time
0	0.0					
1	0.4					
2	0.7					
3	1.1					
4	1.5		4%	4%		5%
5	1.9					
6	2.4					
7	3.0					
8	3.6					
9	4.3					
10	5.1		4%	4%		25%
11	6.0					
12	7.0		4%	4%		30%
13	8.1					
14	9.3		4%	4%		25%
15	10.6					
16	12.1					
17	13.8		4%	4%		10%
18	15.6					
19	17.6					
20	19.8		4%	4%		5%



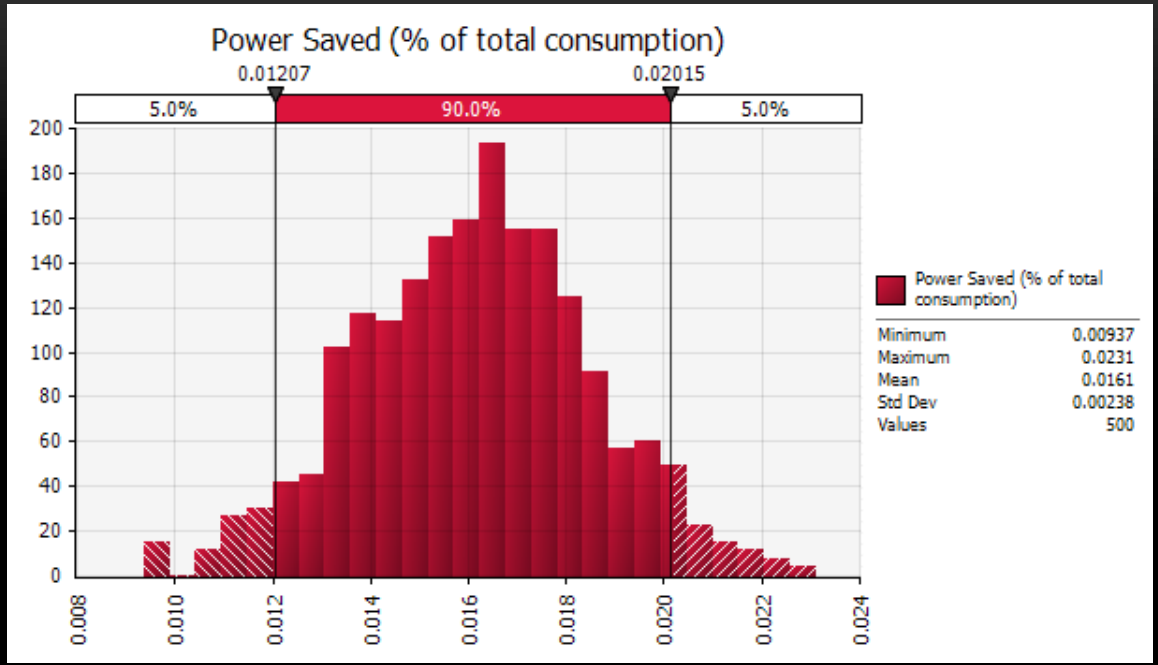
"I save 4% at max speed, so I save 4% EVERYWHERE…"

Implies 100% chance of Success

(Note: Success = 2% savings…)

MY OPTIMISTIC VIEW…

			Savings			Operatons
Speed (kts)	Power (MW)		Low%	High%		%Time
0	0.0					
1	0.4					
2	0.7					
3	1.1					
4	1.5		0%	0%		5%
5	1.9					
6	2.4					
7	3.0					
8	3.6					
9	4.3					
10	5.1		0%	1%		25%
11	6.0					
12	7.0		0%	2%		30%
13	8.1					
14	9.3		0%	3%		25%
15	10.6					
16	12.1					
17	13.8		1%	4%		10%
18	15.6					
19	17.6					
20	19.8		2%	5%		5%

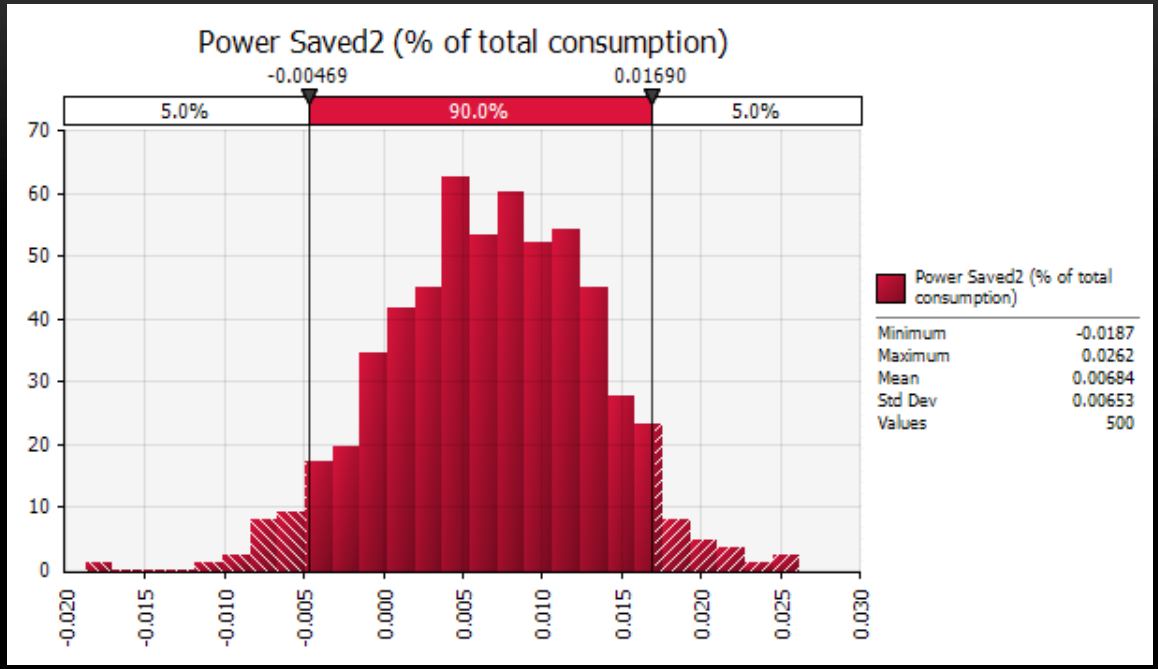


"I MIGHT save 4% at max speed, but I can't expect to do that at lower speeds…. Still, it never costs me additional fuel."

Implies 5.5% chance of success

MY REALISTIC VIEW

			Savings			Operatons
Speed (kts)	Power (MW)		Low%	High%		%Time
0	0.0					
1	0.4					
2	0.7					
3	1.1					
4	1.5		-6%	0%		0.05
5	1.9					
6	2.4					
7	3.0					
8	3.6					
9	4.3					
10	5.1		-5%	1%		0.25
11	6.0					
12	7.0		-3%	2%		0.3
13	8.1					
14	9.3		-1%	3%		0.25
15	10.6					
16	12.1					
17	13.8		1%	4%		0.1
18	15.6					
19	17.6					
20	19.8		2%	5%		0.05



"I MIGHT save 4% at max speed, but I can't expect to do that at lower speeds…. AND, it might cost me additional fuel.

Implies 0.0% chance of success

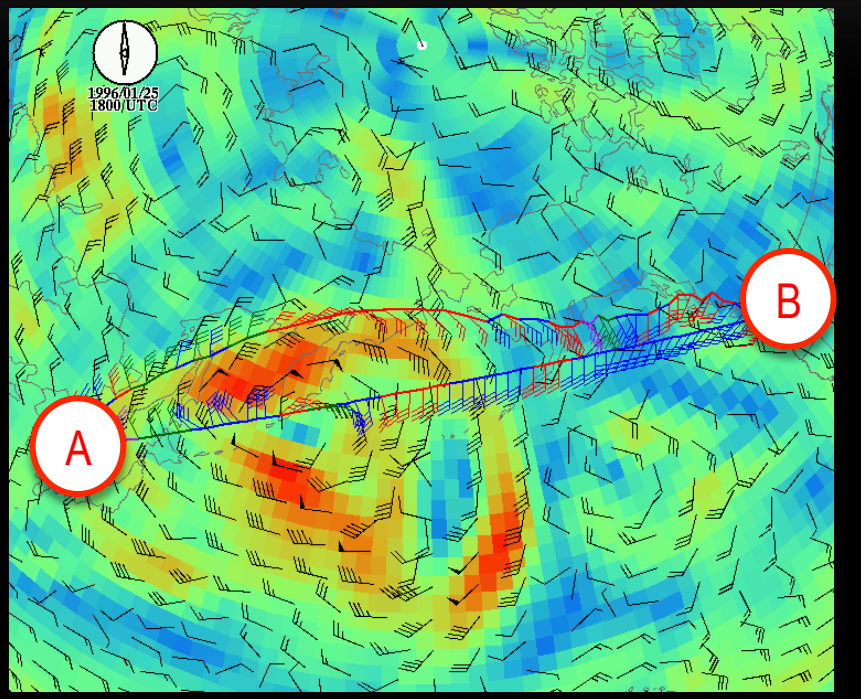
(unless I vary % Time too, in which we have a 1.3% chance…)

GOING BEYOND TRADITIONAL MISSION ANALYSIS

- We have a tradition of considering whether (and often even how well…) a design concept satisfies key requirements…
  - This is the bread and butter of traditional mission analysis efforts
  - It is extended considerably further by things like what Dr. Sarma showed yesterday (Route Optimization Algorithm)
- Where we must do better is in tying in cost and risk into our analyses…
  - As independent variables in design activities
  - As an assessment criteria within Synthesis elements of the SE process.
- Moreover, once we identify that there is an "issue" as a result of Cost and Risk analyses, we MUST drive change processes off them.
  - If it doesn't work now, how is it going to magically get better as we dial in more and more complexity?

A SLIGHTLY BIGGER TOY PROBLEM (TO SUGGEST A WAY AHEAD…)

- Say we intend to operate cargo airships, as a regularly scheduled service between A and B
  - Using techniques like Dr. Sarma described, we characterize unique aspects of airship ops along that route
    - e.g. a 6.5 % longer distance travelled leads to a 20% shorter transit time
  - We still end up with a huge amount of unknowns to include…
    - How do those optimal routes play out over a wider variety of considered weather patterns
    - What are the implications of those longer routes, under different loading, during different times of the year, on the operational availability of the airship
    - What about the rest of the “Problem Solving Enterprise”? Ground Crew, Maintenance, Payload Availability, etc.



AIRSHIP OPS MODEL - INPUTS

- Define some distributions on Costs per Hour…

Cost Factors	Units	Base	Minimum	MostLikely	Maximum	Minimum	MostLikely	Maximum
Maintenance	$/Maint Hour	100	0.80	1.00	1.50	80	100	150
Flight Crew	$/Flight Hour	200	0.80	1.00	1.50	160	200	300
Ground Crew	$/OpHour	50	0.80	1.00	1.50	40	50	75

- Define some distributions on relevant Operational Parameters

Operational Parameters	Units	Base Rate	Minimum	MostLikely	Maximum	Minimum	MostLikely	Maximum
Fuel Consumption Rate	gals/hr	50	0.50	1.00	2.00	25	50	100
Fuel Cost	$/gal	5	0.50	1.00	2.00	2.5	5	10
Average Tons per Trip	tons	50	0.50	0.75	1.00	25	37.5	50
Average SOG	kts	100	0.75	1.00	1.25	75	100	125

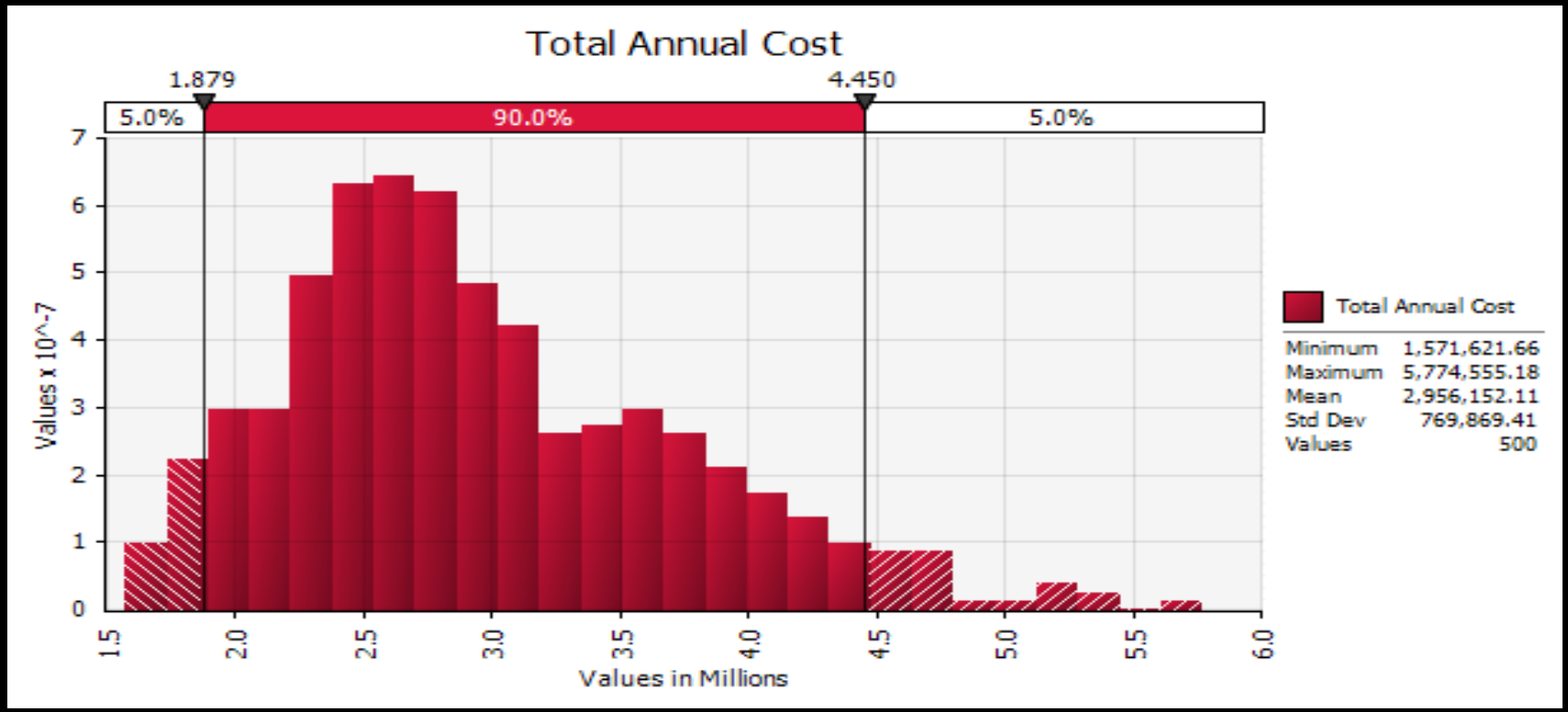
- Define some distributions that nominally represent the anticipated usage profile

Monthly Utilization	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Transit Days	5	5	5	8	7	5	5	5	7	8	8	5
Operational Days	10	10	10	12	15	20	20	20	15	12	12	10
Maintenance/Survivial Days	15	15	15	10	8	5	5	5	8	10	10	15

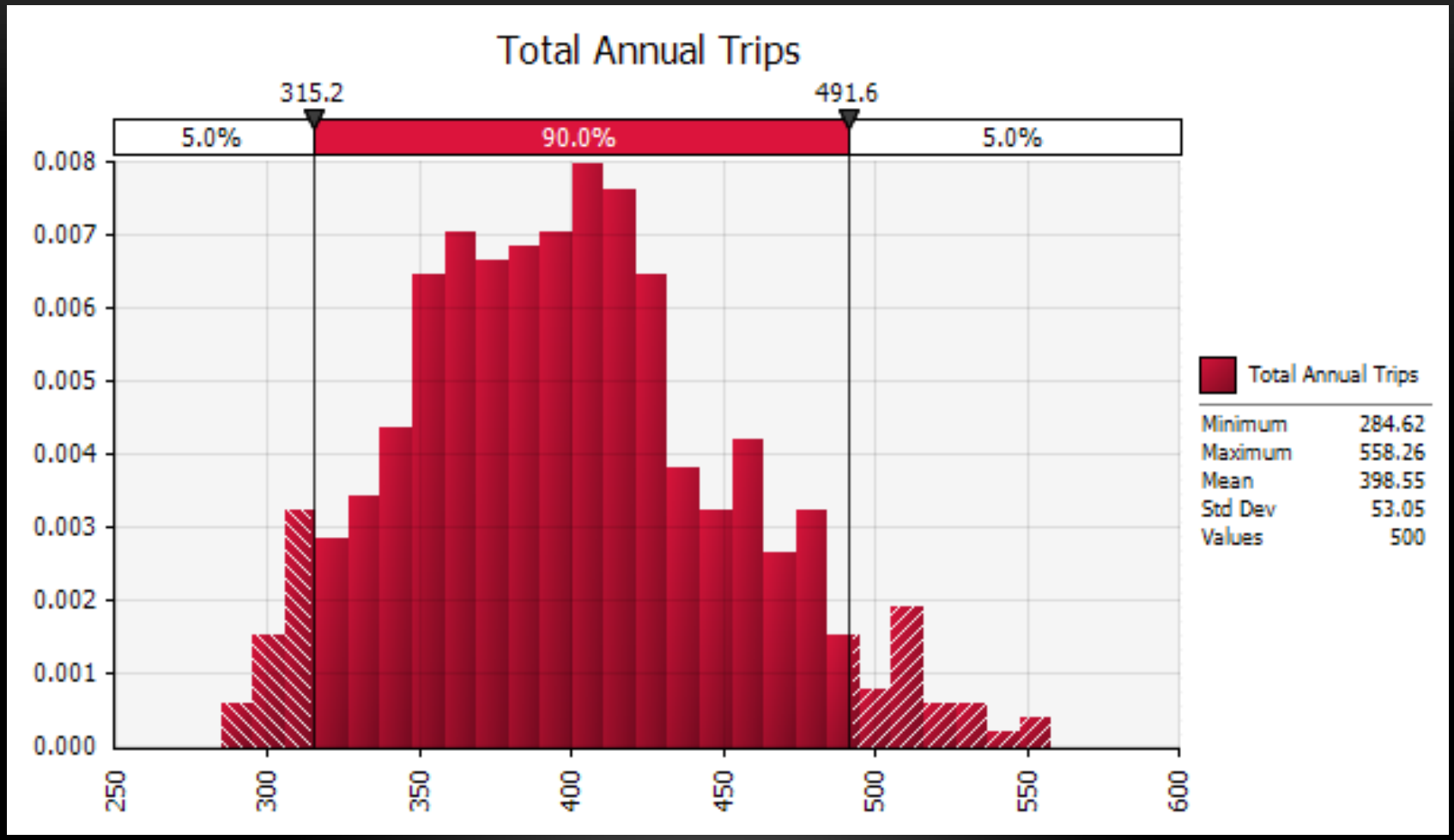
AIRSHIP OPS COST MODEL – COST OUTPUT

Monthly Utilization		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Transit Days		5	5	5	8	7	5	5	5	7	8	8	5
Operational Days		10	10	10	12	15	20	20	20	15	12	12	10
Maintenance/Survival Days		15	15	15	10	8	5	5	5	8	10	10	15

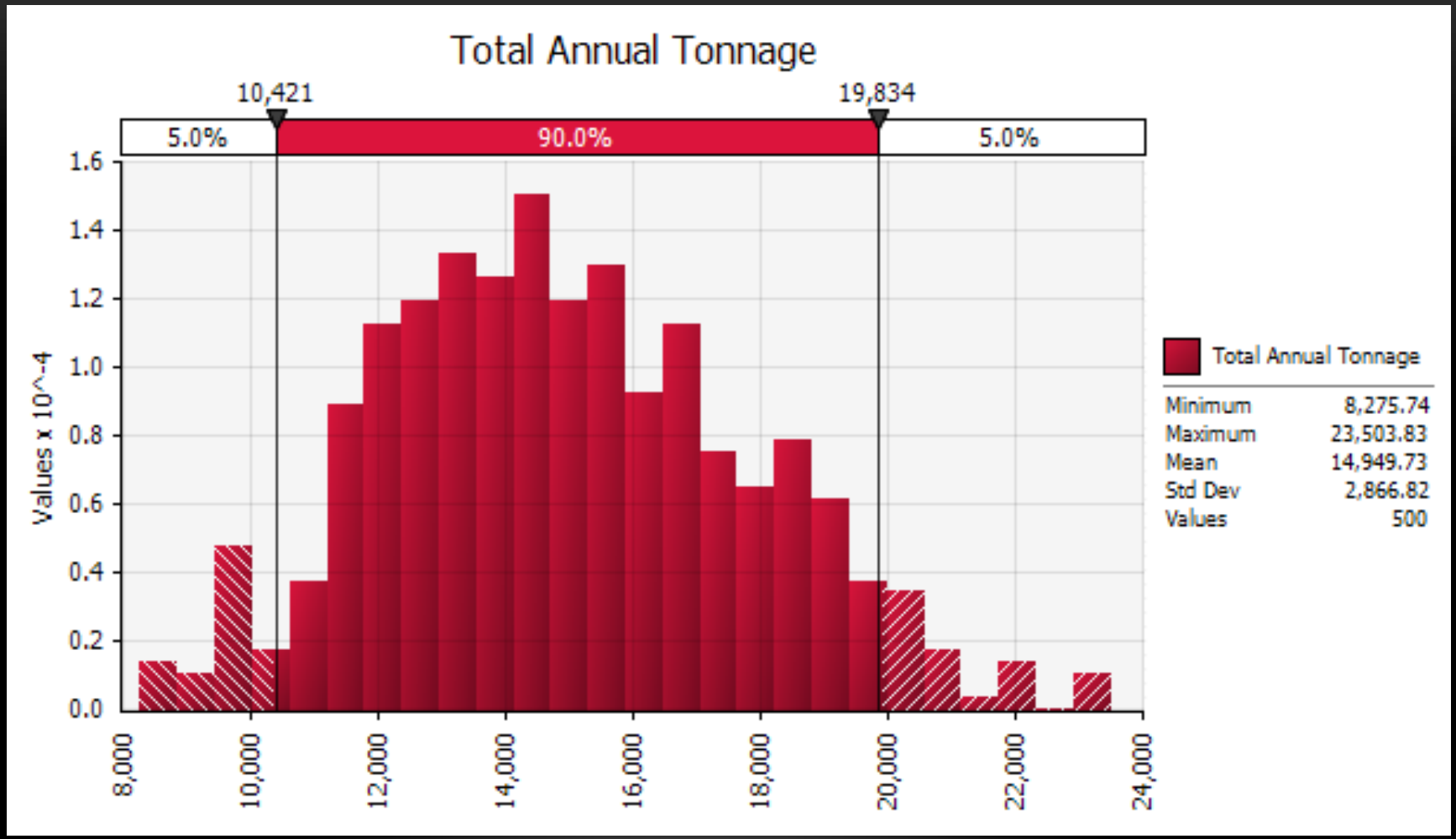
Actual Costs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Maintenance	16500	16500	16500	11000	8800	5500	5500	5500	8800	11000	11000	16500	133100
Flight Crew	44000	44000	44000	84480	92400	88000	88000	88000	92400	84480	84480	44000	878240
Ground Crew	15125	756	756	798	935	1169	1169	1169	935	798	798	756	25163
Fuel and Stores	122500	122500	122500	163333	179667	204167	204167	204167	179667	163333	163333	122500	1951833
Total	198125	183756	183756	259611	281802	298835	298835	298835	281802	259611	259611	183756	2988336



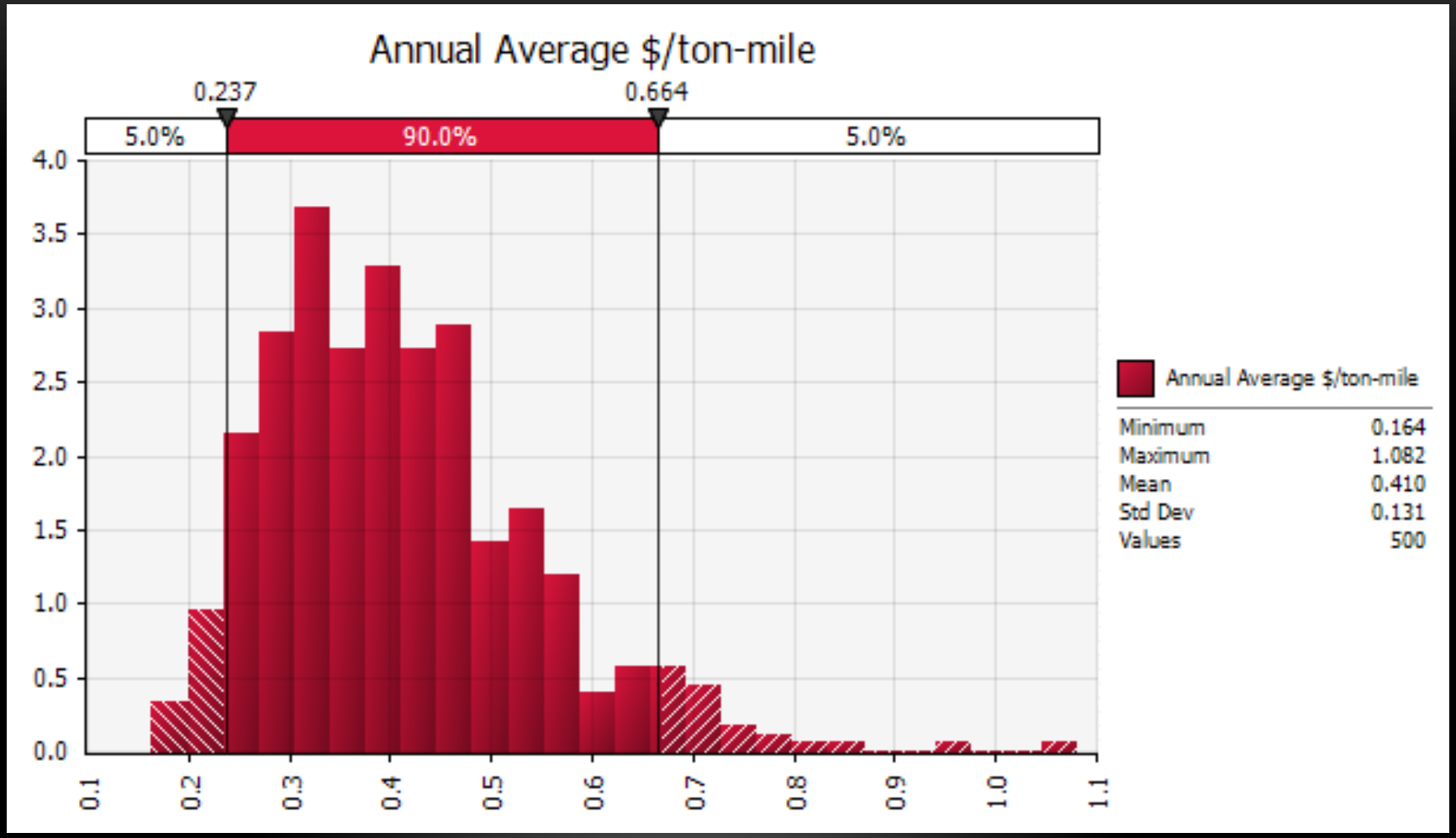
AIRSHIP OPS COST MODEL – TRIPS OUTPUT



AIRSHIP OPS COST MODEL – TONNAGE OUTPUT



AIRSHIP OPS COST MODEL – FREIGHT RATE



A (POSSIBLE) WAY AHEAD (1/2)

- Run Dr. Sarma's model (or something like it) over a wide variety of conditions…
- Probabilistically weight the likelihood of bins of those conditions…
- Characterize the resultant impact on the amount of fuel consumed, transit times, etc. in a stochastic sense (i.e. as a DISTRIBUTION)
- Use that probabilistically governed outcome set to assess what the expected outcomes of the enterprise operating in this regime would be…

A (POSSIBLE) WAY AHEAD (2/2)

- And since I said “enterprise”, we should elaborate a bit on that point…
  - This effort will be even harder if we fail to elaborate on, plan for, and execute programs to support the entire need set in an integrated way
    - It’s not just understanding the customers, and their needs
    - It’s not just understanding the physics of the airship(s)
    - It’s not just understanding the nature of the regulatory landscape
  - On Wednesday, Mr. Madden referred to a “Problem Solving Enterprise”
    - This is an Outstanding Catch Phrase for what we are talking about
    - But we also need to recognize that the nature of the commercial, civil, and defense customer spaces are not the same
      - On the up side… they do overlap. At least a little…

NEXT STEPS

- Roll up sleeves
- Get cracking on some higher fidelity models
  - Leverage the good works already done
  - Focus on not only the parameterization (what is included), and the relationships (how do they interact), but also the distributions on the input parameters
  - Do NOT get paralyzed but what is not known…
- Exercise those models
  - Use them as a stalking horse for identifying the real drivers of the behavior of the Problem Solving Enterprise
- As more is learned, extend the models to maintain their currency and utility
  - At some point, these models can themselves become a part of operational forecasting and enterprise management…

QUESTIONS?